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# THE JOURNAL

## OF

# THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR
C. A. CHANT
*University of Toronto, Toronto*

ASSOCIATE EDITORS

J. S. PLASKETT
*Director of the Dominion Astrophysical Observatory, Victoria, B.C.*

J. PATTERSON
*Director of the Meteorological Service of Canada, Toronto*

R. MELDRUM STEWART
*Director of the Dominion Observatory, Ottawa*

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## THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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PLATE III

SOLAR CORONA, ECLIPSE OF AUGUST 31, 1932.

Taken with a 6-inch refractor, f = 96 inches, by an expedition of Jesuit scientists from Montreal. (Magn., 1.7 X)

PLATE IV

INNER CORONA AND PROMINENCES

Taken with 6-inch refractor (Mgm. 1.7 X)

THE JOURNAL
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OF CANADA

Vol. XXVII, No. 5 MAY-JUNE, 1933 Whole No. 224

# A REPORT OF OBSERVATIONS MADE IN THE REGION OF SOREL DURING THE SOLAR ECLIPSE OF AUGUST 31, 1932

(With Plates III, IV)

By E. CAMBRON, S.J.

THE object of these notes is to give the result of some amateur work done by a party of Jesuit professors from Montreal at Ile Saint-Ignace, near Sorel, Que.

A week before the 31st of August we settled on the southern end of the island, at a villa owned by the Order. The site had an unobstructed view of the sky and horizon, with a pure atmosphere free from smoke and dust, and was well within the band of totality, indeed near its calculated centre. Several piers of concrete already existing on the grounds served admirably for the installation of our instruments.

The main piece of apparatus of our temporary observatory was a Clark refractor of 15 cm. (6-inch) aperture and 245 cm. focal length, mounted equatorially and having its eye-piece replaced by a photographic attachment (Fig. 1), our aim being to obtain as good pictures as we could of the corona.

We had also among our accessory apparatus: a 4-inch refractor, a meridian circle, transits, a barometer, a thermograph, a long-wave radio-receiver to obtain the correct time from Washington. Such was the simple equipment of our informal expedition.

The point was established as being in 73° 8′ 56″ long. W., and

46° 3′ 21″ lat. N. The elevation above sea level was approximately 50 feet.

It was agreed to take four pictures of the sun between the beginning of the eclipse and totality, then to make one exposure of 40 seconds for the corona, another one of 20 seconds, to be followed by a very short exposure on a more rapid plate for the prominences.

At the time of sunrise, it seemed doubtful whether the day would be fine. The temperature record shown in the accompanying

FIG. 1. SIX-INCH AND FOUR-INCH REFRACTORS.

cut (Fig. 2) shows also the variations of our hopes during the time that preceded the eclipse: they went up until ten, down until 12, and up again until 2 p.m.

When the eclipse began, there was a heavy bank of clouds low down on the horizon, and clouds overhead, with a clear lane of bright sky in the space between, where the sun was: and the wind, of small velocity, which kept blowing from the south without any

noticeable change in speed or direction during the eclipse, carried the clouds along the free lane.

During that time the temperature, recorded on our Richard thermograph, was falling off regularly. The instrument, which had been placed in the shade on a verandah facing the wind, registered a total fall of 5° C. between the beginning and the total phase of the eclipse. (The actual fall was surely slightly greater, because the thermograph pen always lags on account of friction.)

As time approached for totality, a thin film of milky appearance screened the sun. Nevertheless, the corona burst forth with magnificence, with a suddenness and sharpness which left no doubt as to the exact instant of its appearance, which we of course recorded.

The numerous fiery red prominences could well be seen with the unaided eye, as could also the red colour of the chromosphere:

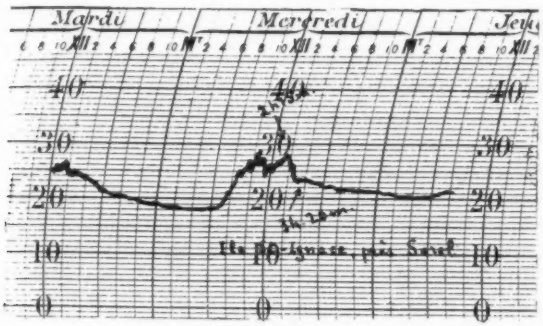


FIG. 2. TEMPERATURE RECORD, AUGUST 31, 1932.

their appearance through the transit telescope was simply gorgeous.

The picture here given of the corona (Plate III) was taken on an Eastman Royal Polychrome plate, with 40 seconds exposure. As this plate, contrary to the order given when it was bought, was not backed, the prominences produced small halos, but they give thereby a signal proof of their existence by the small indentations in the moon. The prominences are shown also on Plate IV.

As is known, the magnificent work done at Parent also shows most plainly the prominences. This work at Parent was done practically under the very same conditions of weather that we had at Sorel, with a slight haze covering the sun.

Now this might bring up an interesting question, if the statement made to the author by a scientist who was at Louiseville were definitely confirmed, viz., that with a perfectly clear sky at Louiseville, no prominences could be seen. As the Parent plates and our plates recorded them and eyes saw them, they certainly were there. If it were proved that they could not be seen at Louiseville, neither by eye nor by plate, we would have to look for a reason for it, perhaps in the fog-penetrating power of longer wave-lengths.

The light cloud which covered the corona must have been responsible for our not obtaining with more detail its delicate structure, but the results we obtained were quite gratifying.

The corona is evidently of the medium activity type, the minimum being due for 1935. Moreover, this corona bears a striking resemblance to the one photographed at Hernösand, Sweden, by Rev. A. L. Cortie, S.J., on August 21, 1914, and published by Phillips and Stevenson in "The Splendour of Heavens" (p. 225).

In our photograph, the corona is seen to be much less extended at the north pole, where streamers can be noticed. One can also see in the picture a decided flattening of the east limb of the moon, which shows also plainly on the pictures taken at Parent by the Greenwich observers. We know that this has been considered at least as a partial cause of the few seconds by which according to them the beginning of totality was delayed.

Collège Ste-Marie, Montreal,
March 11, 1933.

---

NOTE: The time of totality had been announced for Sorel, by Professors Shaw and Douglas of McGill University, as 3.22.58 Standard time, with a probable duration of 100 sec. The duration of totality was decidedly shorter than expected but its beginning came very close (3.22.57) to the predicted time for Sorel, and our station was "in line" with Sorel with respect to the path of the shadow.

# PLOTTING THE MOON'S SPEED ACROSS THE SUN

By John B. Lalime, S.J.

The pictures we obtained of the sun with our larger telescope being quite sharp and of fairly good size (22.32 mm. in diameter), we thought it would be interesting, from measurements made on the negatives, to plot a graph showing the apparent rate of progress of the moon across the sun.

The "still uncovered" part of the sun's diameter, measured along the line of centres of sun and moon, is plotted in the accompanying graph (Fig. 3) against time as ordinate. With such units, the curve represents the seconds-per millimetre taken by the moon's shadow to eat out the sun's image on the negative.

| Phases | Time of pictures (corrected) p.m. E.S.T. | Uncovered diameter (mm.) | Interval (seconds) | Dist. (mm.) | Average rate: sec. per mm. |
|---|---|---|---|---|---|
| I | 2h 14m 57s | 21.88 | | | |
| II | 2h 29m 57s | 17.80 | 900 | 4.08 | 221 |
| III | 2h 43m 57s | 13.50 | 840 | 4.30 | 196 |
| IV | 2h 58m 57s | 8.68 | 900 | 4.82 | 187 |
| Totality | 3h 22m 57s | 0 | 1440 | 8.68 | 166 |
| —ends | 3h 24m 30s | | | | |

(It would be a simple matter to express the rate in other units, for instance in seconds of arc of the sun's diameter per minute of time.)

The curve shows that the moon apparently moved *faster and faster* as it passed across the sun. It would be a good problem, and a neat substitute for jig-saw puzzles, to determine what were the respective parts played by the earth and the moon in that resultant apparent motion of the moon across the sun.

Incidentally, the graph provides a good approximation for the time of first contact. As the first phase was taken soon after the beginning of the eclipse, the curve produced with its "appropriate" curvature until it cuts the 22.32 mm. ordinate gives the first contact

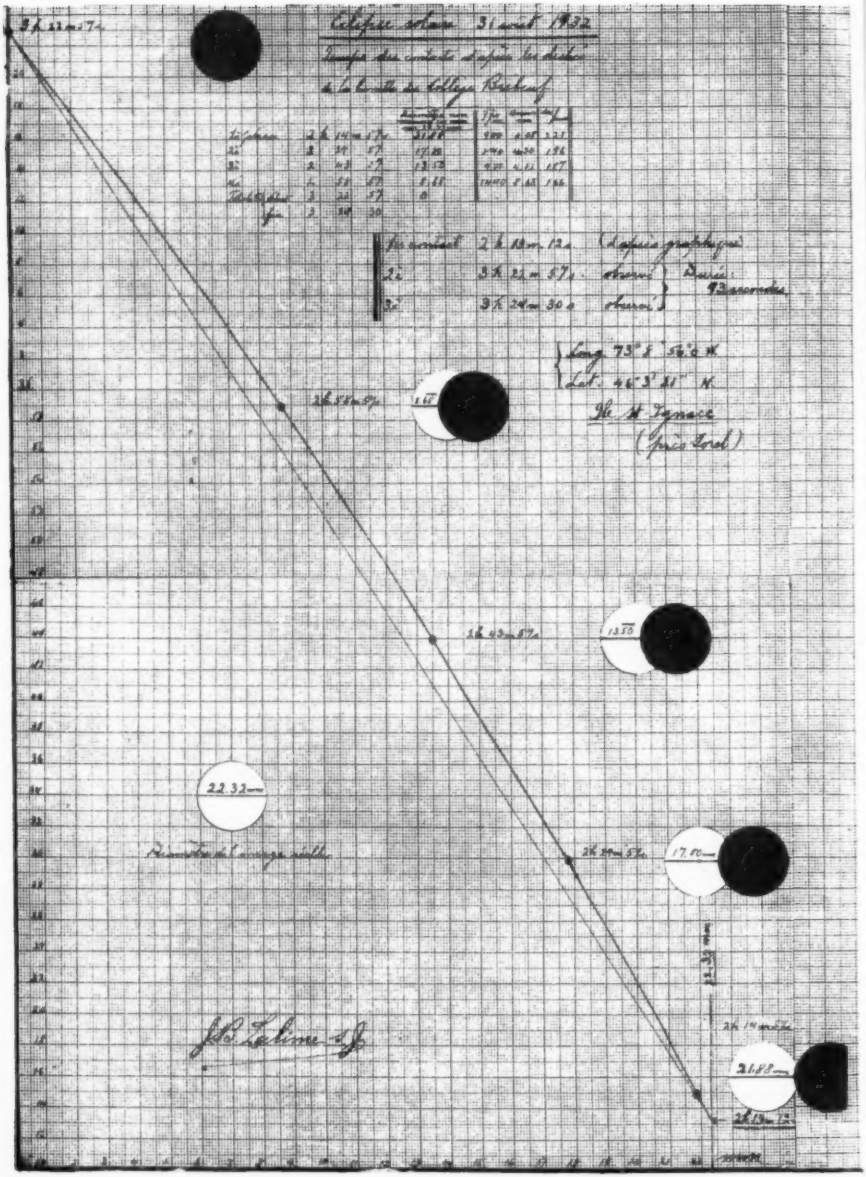
Éclipse solaire 31 août 1932
Temps des contacts définis les dessins
à la Cité du Collège Rochon
Long 73° 8' 58.2 W
Lat. 46° 3' 21" N
Ile N Tymace
(Pointe Noire)
Jules Talbot S.J.

FIG. 3. PLOT OF THE MOON'S SPEED ACROSS THE SUN, ECLIPSE OF AUGUST 31, 1932.

as taking place at 2h 13m 12s, which is accurate within a few seconds.

In the table are mentioned the observed times of beginning and ending of totality, giving 93 seconds for totality as carefully measured by means of chronometers, the point of observation being at latitude 46° 3′ 21″ N. and 73° 8′ 56″ W.

Jesuit Scholasticate,
Montreal,
March 11, 1933.

# THE AUDIBILITY OF THE AURORA AND ITS APPEARANCE AT LOW ATMOSPHERIC LEVELS

By C. S. Beals

THE earliest reference to a sound accompanying the Aurora, of which the writer has any knowledge, is due to Samuel Hearne.[1] It consists of a description of sounds heard by him in his famous journey from Hudson Bay to the Arctic Ocean in 1770. Hearne expressed surprise that the sound had not been heard by previous explorers, and describes it as "a rustling and crackling noise like the flapping of a large flag in a gale of wind." He claims to have heard this sound during auroral displays, both at Great Slave Lake and at different times on the Churchill river.

Another early reference is by David Thompson.[2] He spent the winter of 1796-97 at Reindeer Lake, Saskatchewan, and writes the following account of a brilliant aurora seen by himself and his men.

"In the rapid motions of the Aurora, we were all persuaded that we heard them, reason told me that I did not but it was cool reason against sense. My men were positive that they did hear the motions of the Aurora, this was the eye deceiving the ear: I had my men blindfolded by turns and then enquired of them if they still heard the motions of the Aurora. They soon became sensible that they did not and yet so powerful was the illusion of the eye on the ear that they still believed that they heard the Aurora".

In 1879 J. R. Capron[3] published descriptions by a number of observers, of the sounds which they considered to be associated with the aurora. These sounds are described as "hissing, whizzing, rustling, crackling or rushing". Capron himself was inclined to decide against the reality of the sound, partly because he had never heard it himself, and partly because of the negative evidence given by many arctic travellers and explorers.

There is a reference in Nature[4] to observations of Major Dawson

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[1] "Journey from Prince of Wales's Fort in Hudson Bay to the Northern Ocean in the Years 1769, 1770-1 and 1772." p. 235, Champlain Society's Edition, Toronto, 1911.

[2] Narratives of Exploration in Western America.

[3] Aurorae and Their Spectra, E. and F. N. Spon, London, 1879.

[4] Nature, *35*, 435, 1887.

in charge of the British Polar Station at Fort Rae, N.W.T., in the winter of 1882-83. He described the sound of the Aurora as "like the swishing of a whip or the noise produced by a sharp squall of wind in the rigging of a ship".

At about the same period there is the record of an investigation on the sound of the Aurora conducted by Sophus Tromholt[5] in Norway. He sent out a large number of circulars containing the following query—"Have you or your acquaintances ever heard any sound during Aurora, and if so, when, and in what manner?" He received some 92 affirmative replies against 20 negatives. The sounds heard were variously described as "whizzing, hissing and crackling, whispering, rushing, tearing of silk, as wind in the trees, like the crackling of a fire, as the flapping of a ship's sails, the noise of flying birds, the sweeping of sand, etc."

The following interesting report, dating back to 1888, has been communicated to me by an official of the Department of the Interior, Ottawa. It is by William Ogilvie, who is described as an exceptionally careful observer.

"As to the Aurora making an audible sound, although I often listened when there was a brilliant display and despite the profound stillness which is favourable to hearing the sound, if any sound occurs, I cannot say that I ever even fancied I heard anything. I have often met people who said they could hear a slight rustling noise whenever the Aurora made a sudden rush. One man, a member of my party in 1882, was so positive of this that on the 18th of November when there was an unusually brilliant and extensive display, I took him beyond all noise of the camp, blindfolded him and told him to let me know when he heard anything, while I watched the play of the streamers. At nearly every brilliant rush of the auroral light he exclaimed: "Don't you hear it?" All the time I was unconscious of any sensation of sound."

More recently, Dr. C. A. Chant, editor of this JOURNAL, has taken a keen interest in the Aurora and has conducted extensive investigations with the object of discovering new evidence concerning auroral sounds. The data which he has collected as well as contributions by others have appeared in different numbers of the JOURNAL, as follows:—[6]

In Vol. 17, p. 273, he has published some 20 or more letters or other communication from persons who have heard sounds accom-

[5]Nature, *32*, 625, 1885.

panying the aurora. In his discussion of the extensive data collected in this paper, Chant comes to the conclusion that the reality of the sound can hardly be doubted. The sounds are usually described as swishing or rustling; more rarely as crackling. In some letters references are made to sharp pops, cracks or reports.

In addition to the evidence which Dr. Chant has collected on auroral sounds, he has published a number of communications from persons who claim to have observed auroral rays or curtains close to the earth's surface.[7]

*16*, 255, 259, 1922; *17*, 273, 1923; *22*, 28, 398, 1928; *23*, 464, 1929.

The evidence in some cases seems reasonably convincing, since the observers saw the auroral streamers against trees, buildings, or other objects on the earth's surface.

Another recent investigation of the reality of auroral sounds and low level displays, has been conducted by James Halvor Johnson,[8] Turner Terrace, San Mateo, California. Johnson had himself heard the sound of the aurora while in Alaska, and on one occasion had observed auroral streamers between himself and the face of a cliff, 1,200 feet high. This observation, which was published[9] in 1927, made such a profound impression on his mind that it led to an extensive investigation begun with the object of ascertaining whether the phenomena observed by him would be confirmed by the observations of others. His method of procedure was to enlist the aid of newspapers in Alaska, U.S., and the Yukon, Canada, and ask for letters from those who had heard auroral sounds or who had observed auroras at low atmospheric levels.

He received many affirmative replies from persons who had heard auroral sounds, and has published some 20 or more letters giving in detail the circumstances under which the sounds were heard, with descriptions of their nature. The sounds are variously described as swishing, hissing, sizzling, rustling and crackling. More than one observer tells of hearing sharp cracks or reports.

In addition to the evidence as to the audibility of the aurora, Johnson has published a number of communications from those

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[6]Journal R.A.S.C., *1*, 193, 1907; *5*, 154, 1911; *9*, 35, 268, 458, 1918;
[7]Journal R.A.S.C., *9*, 268, 369, 1918; *17*, 305, 1923; *23*, 194, 1929.
[8]Concerning the Aurora Borealis (privately published).
[9]Publ. A.S.P., *39*, 347, 1927.

who have observed auroral curtains or streamers close to the surface of the earth. In every case of such an observation, the auroral light was seen against some object, such as a tree, cliff or building, which would make possible an estimate of its minimum height.

In addition to the evidence presented above, there are two additional isolated references which are of particular interest because the observations in both cases were made by qualified scientists. One of these references, due to Dr. H. D. Curtis,[10] calls attention to certain observations made by him in Cartwright, Labrador, in July and August, 1905. On several nights he heard faint swishing, hissing and crackling noises, which he could only attribute to the brilliant auroral displays in progress at the time. He states that the observations were made under almost perfect conditions of isolation and quiet. On one or two occasions he had the impression, which could not be confirmed, owing to the lack of background objects, that patches of auroral light were close overhead.

A second reference is to an observation of Hans. S. Jelstrup,[11] astronomer to the Norwegian Geographical Survey. He and his assistant, on September 16, 1926, observed a curious faint whistling sound, distinctly undulatory, which accompanied a brilliant auroral display. The sound was heard by both observers to continue over a period of some ten minutes.

Some additional evidence as to low levels may be found in the records of antarctic exploration. In one case[12] an aurora was seen to descend between the observers and Mt. Erebus, and appeared to be as low as 5,000 feet from the observers. There is also an account of several observers together having seen an aurora in a velley below them.

## New Observations

The present investigation was begun mainly as a result of interest in the subject aroused by Johnson's publication, which has already been mentioned. It has generally been considered that there is a zone of maximum auroral frequency which is roughly some 23 degrees from the magnetic pole. It occurred to the writer that a

[10]Science, *54*, 301, Sept. 30, 1921.
[11]Nature, *119*, 45, 1927.
[12]Shackleton, Heart of the Antarctic, p. 361.

greater length of this zone passed through Canada than through any country in the northern hemisphere. Accordingly, it would appear probable that the Canadian Arctic should present conditions exceptionally favourable to the hearing of any sound which might accompany auroral displays. Further, because of the extensive services maintained in Northern Canada by the Canadian Government, the Hudson's Bay Company and the Roman Catholic and Anglican churches, there is available as a source of information a large body of men whose intelligence and education is well above the average, and who have had years of experience in regions where brilliant auroral displays are of frequent occurrence.

The method followed has been to send individual circular letters to persons who have lived or travelled in Northern Canada. Each circular contained the following questions:

1. Have you ever heard any sound accompanying the aurora? If so, what was the nature of the sound?
2. Have you ever observed auroral streamers approach close to the surface of the earth? If so, what were the circumstances under which the observations were made?

In distributing circulars and collecting addresses, the writer has had the assistance of the Commissioner, Royal Canadian Mounted Police; the Director General of Surveys; the Director of Signals, Department of National Defence; and various other officials of the Canadian Government. He has also been aided by the Fur Trade Commissioner of the Hudson's Bay Company and many members of the Roman Catholic and Anglican clergy of Canada and Alaska. Assistance has also been given by the Yukon order of pioneers, whose members have furnished a number of sworn statements concerning their experiences with the aurora. In addition to reports from these sources, many letters have been received from others whose addresses have been secured in one way or another during the past two years. Replies to questions have been received from practically every province in Canada, and from many widely separated points in the Canadian Arctic.

In order to gain an idea of the nature of the communications received, a considerable number of extracts from them have been printed here. Dr. J. S. Plaskett, Director of this Observatory, has kindly consented to read through the letters from which these abstracts are taken, and he is willing to certify that in no case is

the meaning or general impression altered by removal from the context. The extracts refer both to audibility and to the observation of auroral phenomena at low levels.

The extracts are as follows:—

(1)

With reference to your letter of the 22nd instant relative to the Aurora Borealis, I am rather at a loss to know just what to say. In reply to your first question, I feel quite convinced that I have heard, and quite distinctly heard, a sound accompanying the Aurora. On the other hand, I realize that scientists may prove conclusively that the Aurora makes no sound. In such case it would be apparent that I must have been mistaken. However, I do not think I was mistaken. The sound I heard on more than one occasion when living in the Yukon was, I believe, unmistakably caused by simultaneous flashes of the Aurora.

The nature of the sound might be described as swishing. To be more precise, it was like that produced by a handful of birdseed being thrown in the air to fall on a hardwood floor.

Signed, F. H. Kitto,
Director, National Development Bureau,
Department of the Interior, Canada.
Jan. 31st, 1931.

(2)

Q. Have you ever heard sound accompanying the Aurora? If so, what was the nature of the sound?

A. Yes, quite distinctly, and it was of a hissing or swishing noise, as of someone shaking a wisp of straw and in some cases it was so pronounced that one almost instinctively turned around to see if anything was following.

The observations giving rise to the above answer were made whilst at Langton Bay, N.W.T., during the winter of 1928-29.

Signed, A. F. C. Tudor,
Constable, Royal Canadian Mounted Police,
Winnipeg, Man., Jan. 13, 1931.

(3)

In reply to question No. 1, I might state that I have personally heard sounds accompanying a display. They were of a cracking nature not unlike the crack of a whip, and also a swishing sound. They were distinctly audible on a clear calm night of extremely low temperature, and the stars also appeared to assume an unusual brilliancy.

Signed, G. I. MacLean,
Gold Commissioner, Yukon Territory,
March 21, 1931.

(4)

Certainly where there is an unusual display of Northern Lights and where they are not only very active, but cover the whole sky, there is a peculiar faint noise, so faint that unless there is absolute silence it cannot be heard. Often I have heard it where the blanket was over my face and I did not know that "the lights were on". But whether it comes from the Aurora or not I was not able to determine. It sounds like two pieces of paper being softly drawn over one another. This description, of course, I had heard many times before I had seen the lights. But it fits very well. I made many experiments of stopping my ears and then suddenly exposing them, and always the same sound was again heard. I wondered at the time whether it might not be the action of the intense cold on the eardrums, as it is very akin to the singing in one's ears caused by coming down rapidly from a high to a low level. Moreover, the noise is not steady, but seems to wax as the streamers form and re-form into various patterns. On clear cold nights when there was no display of lights, I have tried to distinguish the same sound, but could not do so.

Signed, Geo. A. Mulloy,
Forest Service, Department of Interior,
Ottawa, Jan. 27, 1931.

(5)

I have certainly heard the Aurora many times, both in the Yukon Valley and in the western part of the North-West Territories. The sound resembles that produced by a fluid effervescing, or like the sound made by drawing silk over silk.

I may say that at times the aurora is active enough to produce sound, I have observed it in company with a number of other persons, all of whom agreed as to the sound and described it in a similar way.

Signed, L. T. Burwash,
N.W.T. and Yukon Branch,
Department of the Interior, Ottawa,
Jan. 27, 1931.

(6)

*One night in January, 1908, between one and two a.m., when returning to our house at five above Discovery on Sulphur Creek, Yukon Territory, from fifty below Discovery, where a dance had been held, Mrs. Baird and I saw a wonderful display of northern lights.

They were close at hand, exceedingly vivid and a noise like the swishing of a silken garment with an occasional crack, was distinctly audible.

We had seen many similar exhibitions, but had never before known them accompanied by the peculiar rustling noise.

Signed, Andrew L. Baird,
Manager, Yukon Consolidated Gold Co. Ltd.,
November 30, 1931.

(7)

*One night in January, 1908, the exact date I do not remember, approximately fifty people had gathered at a dance held in the hall at fifty below Discovery on Sulphur Creek, Yukon Territory.

Between one and two o'clock in the morning someone came into the hall and said that the northern lights were unusually brilliant and suggested that we go out and see the display.

Everyone in the hall went immediately and we saw the most beautiful panorama I have ever witnessed. The lights were quite close and the colours unusually bright. A sound like the swishing of silk was distinctly heard. Everyone present heard it and commented on it. Many said it was the first time they had heard the sound clearly.

Signed, R. L. Allen,
Land Registrar, Dawson, Y.T.,
November 30, 1931.

(8)

Answer to question No. 1:

Yes. On several occasions in the winters of 1924-25 and 1925-26 at Norman and Simpson, N.W.T. The sound is similar to the long drawn articulation of the word SHOE through pursed lips. The natives (Eskimos) along the arctic coast, that I have spoken to, all said that they had heard the aurora borealis.

Signed, A. N. Bames,
Aklavik, N.W.T.,
Inspector, Royal Canadian Mounted Police,
April 20, 1931.

(9)

I have several times in the past heard a distinct swishing noise accompanying the aurora, but only on very cold clear nights. The occasion that is very clear in my mind is that on about the 10th or 12 th of January, 1927, I was crossing Wellington Bay on the south side of Victoria Island and had camped about midway between the north end of Finlayson Islands and Cape Peel. It was a bitterly cold night and upon coming out of the Snow house about 10.30 p.m. the moon was full and the aurora borealis was very clear, close to the ground and active. By active I mean it was very vibratory and quick moving in form. I then heard a very loud swishing noise and the aurora seemed to take a downward sweep when the noise occurred, also there were two distinct streamers that seemed to come in contact with the tops of the range of hills about 15 miles north of me. After a few seconds the streamers disappeared and the noise ceased, the aurora was again natural. This was so unusual that I watched for some time, but there was no recurrence of noise or streamers. At this time my dogs were unharnessed and lying curled up in the snow. When the swishing noise came so suddenly and apparently so close, most of them immediately jumped up and commenced to

growl. On going into the snow house again I asked the native who was with me if he had heard any noise, and he stated that he had heard the northern lights move a short time ago.

Signed, F. Anderton,
Sergeant, R.C.M.P., Tree River, N.W.T.,
May 25, 1931.

(10)

Both Reg. No. 10521, Constable May and myself are positive we have heard the aurora many times. I have also questioned a number of Indians, and they definitely assert that they have heard them, especially when camped in the higher altitudes.

The aurora streamers have a sound like the faint swishing of pure silk. I have noticed when the aurora is brilliant, the dogs' ears stand up as if they were listening.

Signed, Corporal A. B. Thornthwaite,
R.C.M.P., Old Crow Detachment, Y.T.

(11)

I believe that sound does accompany the displays, and on many occasions while on hunting trips, sleeping in the open, I have heard this sound which might be compared to the distant rustling of silken drapes, and on these occasions I have noticed distinct uneasiness manifested by dogs in camp.

This uneasiness I have noticed particularly in the white Siberian breed, and the dogs whine and turn about in circles when this sound becomes noticeable.

When sheep hunting in the mountains of the Alaska Range, I have seen brilliant displays and have seen the streamers come down in front of the mountain at night when camped in the valleys.

The brilliant nights in the mountains make the snow covered mountains stand out very clearly, and at times the auroral rays distinctly come between one and the background.

Signed, Douglas G. Preston,
Fairbanks, Alaska, Sept. 23, 1931.

(12)

In reply to your request re aurora borealis: On the night of August 8, 1924, fifteen minutes after twelve, I saw the northern lights, as we call it, waving close to the ground and among the poplar trees, with clear sky above. I went out into a field of wheat close to the house and the light played around me and among the wheat like whirlwings, with a sound like silk rustling, or tissue paper.

Signed, S. G. Squires,
Valparaiso, Sask., Feb. 19, 1931.

(13)

On September 2nd. 1906, I certainly had positive evidence that the auroral streamers came close to the surface of the earth. I was on the south bank of the Yukon river, which at this point is about half a mile wide. The north shore is high wooded hills. The streamers came between me and the north shore and came right to the water's edge. Of this there was not the slightest doubt, as the trees could be seen through the openings in the auroral streamers. I might say that the whole sky was covered with these darting streamers, but to the north I had a special opportunity of observing them. At the time we were attempting to exchange time signals with Vancouver, but the telegraph circuit refused to function.

Signed, F. A. McDiarmid,
Geodetic Survey of Canada,
Formerly Astronomer, Dominion Observatory,
Ottawa, Jan. 29, 1931.

(14)

Report of F. Wolki, half-breed Eskimo:

On Banks Island, N.W.T., F. Wolki said he appeared to be in the midst of auroral curtains coming right down to the ice.

Signed, I. Neary, S.M. (W.O.I.)
Department of National Defence,
Aklavik, N.W.T.

(15)

Q. M. S. Griswold, engineer at this radio station, states that at about eleven p.m. one night late in September or early October of 1925, he personally saw a curtain of aurora approach to within four feet of the surface of the earth. The weather at the time was calm, clear and frosty, but not very cold, and the display was particularly brilliant and coloured, though lasting for only about an hour between eleven and twelve. The curtain, which approached the ground, was pale green, and a two-story building could be seen beyond and through the curtain of light. No sensation could be felt on walking right into the curtain, which disappeared from the view of anyone approaching closely; however; other people about a hundred yards from the curtain could see the observer enter and pass through the curtain. This phenomenon was visible at the same time to groups of observers stationed about three hundred yards apart, with the curtain extending east and west between them. No sound accompanied the display.

Signed, J. C. Pearson, S.M. (W.O.I.),
Department of National Defence,
Port Smith, N.W.T.

(16)

In Juneau it was between 7 and 8 o'clock, if my memory is right. I was to ferry the channel from Juneau to Douglas. Quiet, silent, clear sky.

The aurora consisted of big waves of white rolling from behind the mainland mountain walls, (to the east), and tumbling below some few hundred feet, over the channel whose entire width they covered in the shape of a sheet.

There was audible now and then a light sound as the rustle of a stiff silk robe of a person walking.

The waves had the shape of heavy cylindrical masses rolling down on the channel, and after unrolling themselves into a sheet, they would ascend in spreading over the hills (low mountains) on each side.

Signed, Joseph R. Crimont, S.J.,
Bishop of Alaska,
February 11, 1931.

(17)

Answer to Question 2:

Yes, at the same time as the audibility mentioned in question one. The approximate date was in the month of October, 1921. I was in a canoe on the Slave river, probably half a mile above Fort Fitzgerald, Alberta, returning from a short patrol up river. The time would be about 10 p.m. Weather very clear and a cloudless sky. Suddenly the whole surface of the river was lighted up and the northern lights appeared to be right on the surface of the water, accompanied by the sound referred to in question one. Both banks of the river were discernible, the light being so strong, and at this point the river is of considerable width. It might be of interest to mention that this phenomenon was noticed at a point two miles above the head of a 16-mile rapids, and the greatest display of surface contact appeared to be nearest the head of the rapids.

Signed, Corporal R. A. G. Baker, R.C.M.P.,
Jasper, Alberta, Jan. 26, 1931.

(18)

Answer to Question 2:

Yes. During the month of November, 1929, I was camped on Tagish Lake, Carcross District. Between the hours of 7 and 8 p.m., I walked to the lake for some ice and upon my return to the tent, walking through the willows for about 100 feet, the aurora was all around and through the willows. Everything was very bright and hard on the eyes, in the tent everything I touched seemed to be electrically charged.

Signed, Corporal E. Blatta,
Carcross Detachment, R.C.M.P.,
February 24, 1931.

(19)

One evening several years ago in St. Stephen, N.B., I was about two hundred yards from a building blocking the end of a dead end street when I noticed the streamers of the aurora apparently almost touching the building and extending very close to the ground in the vacant lots adjoining to

the south, then apparently almost touching an old chapel, the next building to the south. The streamers appeared much below the eaves of the two buildings.

There was a slight rustling sound or crackling noise accompanying the streamers.

Signed, H. P. Moulton,
Geodetic Survey of Canada,
Department of the Interior,
Ottawa, Feb. 6th, 1931.

(20)

*9 a.m. a miner by occupation. In the winter of 1914-15 I was residing on Gold Run creek, south-east of Dawson, Yukon.

My cabin was situate on a hillside, approximately 2,000 feet above the creek bottom. I left to visit a fellow miner residing a distance from the creek. When at half a mile from my cabin I suddenly became enveloped by streamers of the aurora, and to tell the truth I thought "my time had come". I didn't know what to do, but made the dash of my life for my cabin. I could see the cabin plainly through and by the light of the streamers. The noise occasioned was a shu, shu, shu, as near as I can describe it. There were also sharp quick cracks, something like a rifle report in the distant bush would sound. That's the best description I can give of the cracking, which was quite distinct.

Signed, James Lloyd.

*Testimony made under oath.

The extracts quoted above are representative specimens of the reports. Many other similar accounts have been received and the data as a whole may be briefly summarized as follows:

| | |
|---|---|
| Total number of letters received | 141 |
| No. of persons reported as having heard auroral sound | 144 |
| No. of negative reports as to audibility | 40 |
| No. of actual descriptions of sounds | 106 |
| Reports of sound heard but not described | 38 |
| No. of reports of auroral light seen at low levels | 22 |
| Cases in which a background object was clearly seen behind the auroral light | 10 |
| Cases in which the auroral light appeared in actual contact with ground | 8 |
| Cases where observers had the impression of a low level display, but evidence unconvincing owing to lack of background object | 12 |

The description of sounds were almost monotonously similar to one another. Fully 95 per cent. of them come under the headings of hissing, swishing, rustling or crackling. Presumably the terms "hissing" and "swishing" are different ways of describing the same type of sound. The terms "swishing" and "rustling" also seem to be used almost synonymously, as some speak of the "swishing of silk", while others speak of the "rustling of silk" in describing the sound. The term "crackling", on the other hand, seems to refer to a different type of sound, and many observers speak of hissing and crackling or swishing and crackling as though there were a clear distinction between the two. This is illustrated by the following examples of individual descriptions: "feeble crackling, also rustling of silk"; "faint 'sh' sound accompanied by faint crackle"; "shu, shu, shu, sound accompanied by quick cracks"; "hissing, cracking sound", etc. It seems probable, therefore, that the reports may be interpreted as definitely indicating only two distinct types of sound which correspond to swishing and crackling, respectively.

The descriptions of low level auroras are less numerous than reports on audibility, but a number of the observations appear to have been very carefully made, and in some ten cases a low minimum height is fixed by the observation of a background object on the earth's surface. In a majority of cases, trees or nearby buildings provided the background objects, but in two cases the auroral light was seen against a mountain background. The observations of F. A. McDiarmid (No. 13), and H. P. Moulton (No. 19), seem especially convincing, as both of these men are well-known and highly qualified observers.

## Discussion of Data

In discussing the data of this and previous investigations, the first question to consider is whether the phenomena observed have genuine objective reality or whether they are in some way due to the imagination of the observers. The suggestion has frequently been made that the "sound" of the aurora is purely imaginary and due to the rapid motion of the streamers suggesting a sound to the mind. Another suggestion put forward by Samuel Sexton,[13] an American physician, in 1885, is that the so-called sound of the aurora is in reality due to noises in the head, a complaint from

[13] Nature, *32*, 625, Oct. 29, 1885.

which about 50 per cent. of persons suffer. Still another ingenious suggestion has been made to the writer by a number of persons including F. J. Davies, physicist with the Byrd Antarctic expedition. Davies said that he had observed on more than one occasion certain swishing and crackling noises due to the rapid freezing of the moisture in the breath at extremely low temperatures. The possibility that this effect is responsible for the widespread belief in the sound of the aurora must be seriously considered. Finally, there remains the fact that many competent observers who have spent years in the arctic and who have witnessed hundreds of brilliant auroras, have never observed any sound associated with them.

Probably the best evidence in favour of the reality of auroral sounds is that practically all observers who have heard them describe them in the same way. From Samuel Hearne in 1771 to persons who have submitted reports in connection with the present investigation, there is general agreement that sounds associated with the aurora are of a swishing, rustling or crackling nature. Even the descriptions published by Capron, who apparently did not believe in the reality of the sound, correspond closely to those given in communications received during the present investigation.

The suggestion that the sound is due to noises in the head should, perhaps, not be taken too seriously. If this is the real cause it is difficult to see why the sound should be heard only during auroral displays, or why it should be heard only during an occasional display.

The idea that the sound is due to freezing of moisture from the breath is subject to similar objections. There is no reason why it should be heard only during auroral displays. Moreover, it should always be heard when the observer listens intently during a display at 40 or 50 below zero. That this is not so is evidenced by many reports that the sound is heard rarely. Even more convincing evidence against this suggestion is the fact that numerous reliable observers report sounds detected in midsummer, or in the fall when the weather was not extremely cold. *E.g.*, Dr. H. D. Curtis, who heard the sound in Labrador during July and August, 1905.

Probably the greatest obstacle to belief in the reality of the auroral sound is the fact that many residents in the arctic and many

arctic and antarctic explorers have never heard it. Even though the weight of evidence of this and previous investigations is on the affirmative side, it is necessary, if the sound be not attributed to the imagination, to find some logical explanation of this considerable body of negative evidence. From the data of this investigation a number of considerations bearing on this aspect, occur to the writer and it seems probable that, taken together, they should help to reconcile conflicting accounts given by different observers.

1. The first consideration has already been mentioned, and has been repeatedly forced to the writer's attention. It is that the hearing of auroral sounds is a rare occurrence. One observer has estimated that of the brilliant displays which he has witnessed, less than 5 per cent. give rise to audible sounds. Several others state that the hearing of sounds is infrequent in comparison with the frequency of the displays themselves, while there are numerous reports from persons who have spent 20 or 30 years in the arctic but who have heard the sound on only one or two occasions.

2. The second consideration is that of locality. There is some reason to believe that there is a zone of maximum auroral frequency, roughly some 23° from the magnetic pole. It seems very unlikely, however, that conditions along this zone are completely uniform as regards intensity and audibility of the displays. It would appear reasonable to expect a certain amount of local variation, particularly where audibility (presumably a low level phenomenon) is concerned. If this is the case the hearing of a sound might depend on the observer being in a favoured locality.

3. The third consideration has to do with possible difference in acuteness of hearing. In this connection the report of William Ogilvie, quoted in the introduction to this paper, may be of considerable importance. His report appeared to offer conclusive evidence of two observers side by side, one of whom heard the sound, while the other did not. We may be practically certain that there is a considerable range in the ability of persons of "normal" hearing to detect faint sounds or sounds of high pitch. It might well be, therefore, that one observer of ordinarily acute hearing would be incapable of hearing the sound produced by the aurora on ordinary occasions, but might hear it more rarely when it was unusually intense. A second observer with an exceptionally keen sense of

hearing might hear a sound which was completely inaudible to the first. This hypothesis may account for the fact that some observers with wide experience of auroras, report hearing the sound often, others report hearing it very rarely, and still others not at all.

In the matter of low levels auroras the evidence is in most cases reasonably definite and unequivocal. The observers saw the auroral light or streamers outlined against some background object, which seems definite evidence that the displays occurred close to the earth's surface. The evidence as to low level displays provided by the present investigation is substantially similar to that presented by Chant and Johnson. From all three investigations there are some 20 communications in which the observations, as described, seem satisfactory from a scientific point of view and a number of others which are reasonably convincing. It would be easy to dismiss one or two of these observations as due to self-deception or to optical illusion. The majority of them, however, give the impression of being reliable. The fact that two of the observations were made by persons trained in astronomy and precise surveying, adds a considerable amount of weight to the positive evidence.

## Interpretation

The only interpretation of the observations which seems to fit all the facts is that both the sounds and the low level apparitions are real, and that they constitute normal though perhaps unusual accompaniments of other auroral phenomena. If this is so, then there must be some definite physical process taking place close to the earth's surface which is able to produce the effects that have been observed. As far as the writer is aware, suggestions which have been made as to the nature of this process have all tended in one direction. Dr. C. A. Chant[14] has pointed out the similarity of the auroral sound to that of a brush discharge, and has definitely made the suggestion that there is present an unusual electrical condition of the atmosphere, which results in the production of some sort of an electrostatic discharge. A similar suggestion has been made by J. P. Henderson,[15] who has studied the matter from

[14]Jour. R.A.S.C., *17*, 273, 1923.
[15]Jour. R.A.S.C., *17*, 375, 1923.

the point of view of the influence of the aurora on wireless reception. In one of the communications published by Johnson,[16] an observer in Wasilla, Alaska, had frequently seen faint sparks on a metal horse on top of his flagpole during an intense auroral display.

[16]Concerning the Aurora Borealis.

The writer has received numerous communications, both written and verbal, from persons who considered that the sounds which they heard during a display were identical with those heard during certain types of electrical discharge. There have also been received a number of communications stating that land telegraph lines have been seriously affected or put out of commission during intense auroral displays.

The aurora has long been considered to be electrical in origin and the hypothesis that the auroral sounds and low level displays are due to some sort of electrical discharge near the surface of the earth, seems a very reasonable one. There exists convincing proof[17] that some of the phenomena connected with the aurora take place many miles above the surface of the earth. The fact that this is the case does not, however, preclude the existence of electrical and luminous effects at lower levels. Certainly the data of this investigation and the previous ones of Chant and Johnson strongly support the idea that such effects are real. Finally, there remains to point out the fact that the hearing of auroral sounds and the observation of auroral light at low levels represent mutually confirmatory data

[17]Stormer, on the Height of the Aurora Borealis.

in so far as the reality of the phenomena are concerned. If the sounds are due to electrostatic discharge of sufficient intensity to be audible, luminous effects at low levels would be expected to accompany them, and vice versa.

If the evidence presented in this and preceding investigations be accepted as valid, the conclusion necessarily follows that theories of the aurora must be modified in such a way as to take account of the low level phenomena.

Dominion Astrophysical Observatory,
Victoria, B.C.,
November 15, 1932.

# REPORT ON OBSERVATION OF TOTAL ECLIPSE BY BOY SCOUTS, AUGUST 31, 1932

By E. Russell Paterson
*Boy Scout Secretary for Province of Quebec*

*PROBLEM*—The service which was requested of the Boy Scouts by the Eclipse Committee of McGill University was to try to establish the two lines marking the edges of the shadow path where these two lines crossed the Province of Quebec. In order to do this, it was suggested that lines of Boy Scouts be placed for observation at various points, each line extending for about a mile, with the boys at close intervals, the lines of boys being at right angles to, and with their centre on, the lines where it was calculated that the shadow edge would pass. Each boy was to make observations from which it could be estimated afterwards whether he stood inside or outside the shadow when it passed, and it was therefore hoped that it would be possible to obtain several points on each edge of the shadow path marking its extreme limits. When these points were joined up, the actual path of the shadow would be indicated, and it would be possible to check the calculations as to the position of the shadow area which had been made before the event.

*Results in General*—Unfortunately the results obtained appear to be largely negative. The parties of Scouts placed on the western edge of the shadow path were prevented by weather conditions from making any observations whatever, as was the most northerly party placed on the eastern edge. Three other parties on the eastern edge were able to make detailed observations of a more or less definite nature, but in two cases the complete parties appear to have been within the shadow path, while in the third case the estimation of the location of the edge is questionable owing to clouds at the important moment.

*Data*—It was necessary first of all to obtain an estimation of the location of the eclipse path, and, in a letter dated June 15, Dr. R. Meldrum Stewart, Director of the Dominion Observatory, kindly supplied the following data:

| | *Western Limit* | | | | *Eastern Limit* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Latitude* | | *Longitude* | | *Latitude* | | *Longitude* | |
| 3.23 p.m. | 46° | 6.0 | 74° | 10.5 | 46° | 43.6 | 72° | 14.1 |
| 3.24 " | 45 | 42.5 | 73 | 50.1 | 46 | 19.6 | 71 | 53.7 |
| 3.25 " | 45 | 19.0 | 73 | 29.4 | 45 | 55.6 | 71 | 33.0 |
| 3.26 " | 44 | 55.5 | 73 | 8.5 | 45 | 31.7 | 71 | 12.1 |

*Maps*—It was next necessary to have this information transferred to maps, giving continuous lines marking the estimated shadow edges on which convenient points could be chosen for the placing of observing parties of Scouts. The maps to be of any value must be of large scale, and Topographic Maps, 1 inch to 1 mile, issued by the Department of National Defence, were finally chosen as being most suitable for the purpose. A number of these sheets were obtained covering most of the regions over which the calculated lines of the shadow edges passed. Where the eastern edge crossed the St. Lawrence River, no Topographic sheet was available, and a river pilot's map of this section, which also showed details of the shore lines, was used. The problem of plotting the shadow limit lines on these maps was no easy one, as the co-ordinates given by Dr. Stewart were widely spaced, and somewhat laborious calculations of interpolation were required to fix the positions of the lines on the large scale sheets. Mr. W. Bruce Ross, of the Department of Mathematics, McGill University, very kindly undertook this work, and provided us with the lines carefully marked in all regions required.

*Lectures*—To interest the Scouts in the observations, and to provide them with information which would enable them to observe intelligently, a series of lectures was given in the localities from which the Scout observers were to be drawn. Dr. A. Vibert Douglas, of McGill University, kindly gave an illustrated lecture on the Eclipse to Montreal Scouts on April 23. Between this date and June 17, lectures were given by myself in St. Johns, Three Rivers, Shawinigan Falls, Quebec, and Sherbrooke, and a lecture in French was also given in St. Johns by Dr. G. Gardner of the University of Montreal, who is also a Scoutmaster. All these lectures were illustrated with slides kindly loaned by Dr. Douglas. In some cases there was a large attendance of the general public as well as of Scouts.

*Plan*—It was planned that eight parties of Scouts should be placed in position: four on the eastern, and four on the western line, the points chosen being spaced as widely apart on the lines as circumstances permitted. Each party was to consist of about 35 boys placed at 50-yard intervals, thus covering a mile of ground. The parties were drawn from the nearest Scouting centres. Each boy was provided with:

(*a*) An Information Sheet (see below, "Instructions to Observers"), telling him exactly what to look for.

(*b*) A Question Form (see below), giving four questions to be answered by him immediately after the shadow passed. These questions were taken from a question form used in connection with a total eclipse visible in New England a few years ago. From the answers received, it was hoped that it would be possible to tell exactly which boys were inside, and which outside, the shadow.

(*c*) A piece of exposed photographic film through which the sun could be observed.

*Positions of Parties*—The eight parties included 254 observers, and were as follows:

Western Edge—

Party 1—Montreal Scouts, 22 boys, directed by Scoutmaster E. R. E. Chaffey, stationed along Cote St. Luke Road, N.D.G., centred on its junction with Clanranald Avenue.

Party 2—Verdun Scouts, 40 boys, directed by Scoutmaster A. A. Smith, stationed along the bank of the Aquaduct, centred on a small bridge over which the calculated line passed.

Party 3—St. Johns and Delson Scouts, 35 boys, directed by Rover Leader J. Reid. This party was driven in private automobiles 10 miles west of St. Johns to the De Lery junction of the King Edward Highway.

Party 4—St. Johns and Lacolle Scouts, 35 boys, directed by Scoutmaster G. Ellis. This party was driven in private automobiles 15 miles south of St. Johns on Highway 14 to a point between Ile Aux Noix and Lacolle.

(Parties 3 and 4 were organized by District Commissioner Roy Wilson and District Secretary Chas. Maxwell of St. Johns.)

Eastern Edge—

Party 5—Three Rivers Scouts, 17 boys, directed by District

Scoutmaster Thos. Jones. This party was driven 35 miles east of Three Rivers on the south shore of the St. Lawrence, and stationed between two light-houses conveniently located with the estimated line half way between them, near St. Jean Deschaillons.

Party 6—Quebec Scouts, 40 boys, directed by District Scoutmaster George H. Cartwright. This party was driven by autobus 35 miles southwest of Quebec to a point near Lourdes. The Scouts were stationed along the road north of the Bécancour River where the calculated line crosses that stream. A summary of their reports is attached. (The organization of this party was greatly assisted by Col. Wm. Wood of Quebec; it included equal numbers of French-speaking and English-speaking Scouts.)

Party 7—Thetford, East Angus, and Cookshire Scouts, 30 boys, directed by Scoutmaster S. Bateman, stationed near St. Gerard The Scouts were placed along the road on the northwest shore of the St. Francis River, centred on the point where the calculated line crosses the river. A summary of their reports is attached.

Party 8—Sherbrooke Scouts, 35 boys, directed by District Scoutmaster C. G. Price. This party was driven in private automobiles 45 miles northeast of Sherbrooke to Galson, where the estimated line crosses Highway 28. A summary of their reports is attached.

*Observations*—No results whatever were obtained by Parties 1 to 4 on the western edge on account of heavy clouds.

Party 5 obtained an excellent view of the early stages of the eclipse, but at 4.20 p.m., when about 95% of the sun's surface was covered, a very heavy dark cloud intervened, and when it cleared away the moon's disc had commenced withdrawing from the rim of the sun. These few minutes of cloud, therefore, spoiled any chance of observation.

Party 6 had better fortune. Conditions were reported as ideal at the western end of their line, but progressively worse towards the eastern end, and here the heavy cloud at the time of totality also interfered with exact observation. An attempt was made, however, by nearly every boy to judge the time of totality at his station, and while many estimates are obviously out of step, yet there appears to be a progressive diminishing of the period from the centre of the line to Station 8. The Officer in charge of the party suggests that this point represents the edge of the shadow path, 550 yards north-

east of the calculated position. He admits, however, that sky conditions were not at all satisfactory for accurate observation, and we suggest that this result be accepted only as a possible corroboration of more definite results obtained elsewhere.

Parties 7 and 8 enjoyed perfectly clear sky. All stations in these two parties reported themselves within the shadow path. The periods of total darkness, curiously enough, seem to have been estimated as shortest at the centre of each line—a fact which cannot possibly have any significance.

*Accuracy of Observations*—The first three questions asked on the question form were answered by practically all members of Parties 6, 7, and 8. A number of answers were given to the fourth question, but owing to the indefiniteness of the general result of the observations, these answers do not appear to be worth transmitting in this report, though the papers are available if the information would be of value. Some observations reported by the boys may obviously be disregarded as being quite inaccurate. The answer to question 2 (length of time of totality at his station) has been taken as throwing most light on the position of the boy with relation to the shadow path. The periods of totality given by a few Scouts were obtained by the use of watches: in the majority of cases these periods were estimated, and carry just that value which such estimations usually have, the general trend of the calculations being the feature on which conclusions may safely be based. Some Scouts, particularly those forming Party 7, had been drilled beforehand in the estimation of time in seconds, and the results obtained by this party appear to have the most consistent trend.

*Conclusions*—Basing our conclusions on the results obtained from the three parties on the eastern edge which had the opportunity of making observations, we suggest in general that the eastern edge of the shadow path was farther to the northeast than the lines given us on our maps. Judging from the rather unsatisfactory observations of Party 6, the line marking the edge was at least 550 yards farther northeast than the calculated position, and judging from the more definite reports of Parties 7 and 8, this distance may be raised to at least 700 to 900 yards.

While we regret the lack of definiteness in the report we are able to make, we welcome the opportunity of arousing interest in

astronomical things through our lectures. The feelings of those boys who had nothing to observe but a heavy bank of clouds were well expressed by one youngster in Party 1, who disgustedly handed in his question form endorsed, in the jargon of the baseball leagues, "Eclipse postponed on account of rain".

## INSTRUCTIONS TO OBSERVERS

When the total eclipse of the sun occurs on August 31st the shadow of the moon will pass across the Province of Quebec from Northwest to Southeast. The shadow will be 103 miles wide. The task of our Scout observing parties will be to try to determine exactly where the eastern and western edges of the shadow pass, *i.e.*, the two lines which will mark the extreme limits of total darkness on the ground, "the shadow path". The positions where the scientists think these lines should pass have been calculated for us as carefully as possible. We are to stretch several lines of Scouts across these calculated lines to make observations. If each Scout can report after the eclipse has passed whether he was inside or outside the shadow path, we can tell just how far along the line of Scouts the shadow of the Moon reached.

It is important that you should understand how to tell whether you are within the shadow path or not. If there is any instant when no portion of the sun's surface is visible to you, you are inside the path. The sun's light will disappear in a series of bright dots: if the dots appear on the far side of the sun before they disappear on the other side, you are not inside the shadow. There must be at least an instant of TOTAL covering of the sun's face.

Another test is whether you see the corona of the sun—a region of soft, pearly-grey light surrounding the spot where the face of the sun is covered by the moon. If you can see the Corona, even for an instant, entirely surrounding the sun, you are within the path of the shadow. If you cannot see the Corona, or see it only part way around the sun, you are outside the shadow path.

On reporting at your assembly point, a paper will be handed to you on which are four questions. These will indicate the exact things you are asked to observe at the moment of the eclipse, and your answers to these questions will enable our officials to judge whether the position in which you were placed for observation was inside or outside the path of the shadow.

You will also be provided with a darkened glass through which to look at the sun while the eclipse is progressing. Do not attempt to watch the sun without this glass right up to the moment when the light of the sun is disappearing; injury to your eyes may result if you are careless in this matter.

## QUESTION FORM

Question 1.—If the sun is not quite eclipsed at your station there will always be a bright edge of the sun visible, or perhaps only a single point.

One bright point may appear on one edge of the sun before the other has entirely disappeared. At your station was there any time at which no bright edge of the sun was visible? Answer YES or NO .....

Question 2.—If the bright edge of the sun entirely disappeared, how many seconds elapsed before another bright part of the sun became visible? Answer ..... seconds.

Question 3.—The fringe of light surrounding the sun and called the corona is fully visible only if the face of the sun is entirely covered. At your station was there any time at which you could see the corona all around the sun? Answer YES or NO .....

Question 4.—If you are on a hill near the edge of the shadow path, you may be able to see the shadow advancing across the country. If so, what buildings or other landmarks were inside and what were outside the edge of the shadow?

Landmarks inside of the shadow .....

Landmarks outside of the shadow .....

Scout's Name ..... Group .....

| *Station* | *Name* | *Yards from Estimated Line* | | *Question* 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| 1 | Fournier | 900 | East | Yes | Clouds | No |
| | (Station 1 at road intersection) | | | | | |
| 2 | Giroux | 850 | | Yes | 55″ | |
| 3 | Laberge | 800 | | Yes | 50 | Clouds |
| 4 | Marois | 750 | | Yes | 60 | No |
| 5 | Wright | 700 | | Clouds | | |
| 6 | Jess | 650 | | Clouds | | |
| 7 | Hunter | 600 | | Clouds | | |
| 8 | Scott | 550 | | No | | No |
| 9 | St. Cyr | 500 | | Yes | 6 | No |
| 10 | Bazin | 450 | | Yes | 7 | Clouds |
| 11 | Desy | 400 | | Yes | 6 | No |
| 12 | Racine | 350 | | Yes | 6 | No |
| 13 | Arthur | 300 | | Yes | 25 | No |
| 14 | Martin | 250 | | Yes | 34 | No |
| 15 | Warner | 200 | | Yes | 35 | No |
| 16 | Carpenter | 150 | | Yes | 35 | No |
| 17 | Burridge | 100 | | | | |
| 18 | Davy, R. | 50 | | | 2 | Yes |
| 19 | Davy, H. | — | | Yes | 35 | |
| 20 | Good | 50 | West | Yes | 40 | No |
| 21 | Bergeron | 100 | | Yes | 50 | Clouds |
| 22 | Legare | 150 | | Yes | 40 | Clouds |
| 23 | Fournier | 200 | | Yes | 2 | Clouds |
| 24 | Giroux | 250 | | Yes | 15-20 | No |

| *Station* | *Name* | *Yards from Estimated Line* | *Question* 1 | 2 | 3 |
|---|---|---|---|---|---|
| 25 | Ross | 300 | Yes | 15 | Yes |
| 26 | Squarey | 350 | Yes | 18 | Yes |
| 27 | Adanakis | 400 | Yes | 6 | Yes |
| 28 | Poulin | 450 | Yes | 4 | Yes |
| 29 | April | 500 | Yes | 5 | Yes |
| 30 | Fr. de Smet | 550 | Yes | 10 | Yes |
| 31 | Girard | 600 | Yes | 11 | Yes |
| 32 | Langlois | 650 | Yes | 36 | Yes |
| 33 | Martel | 700 | Yes | 20 | Yes |
| 34 | Bernier | 750 | Yes | 28 | Yes |
| 35 | Beaule | 800 | Yes | 25½ | Yes |
| 36 | Dion | 850 | Yes | 28 | Yes |
| 37 | Denis | 900 | Yes | 31½ | Yes |
| 38 | Gillard | 950 | Yes | 9 | Yes |
| 39 | Wardwell | 1000 | Yes | 10 | Yes |
| 40 | Beauchemin | 1050 | Yes | 32½ | Yes |

SUMMARY OF REPORTS—PARTY 7—NEAR ST. GERARD

| | | | | | |
|---|---|---|---|---|---|
| 1 | Bourgault | 650 N-E | Yes | 11" | Yes |
| 2 | McCallum, A. | 600 | Yes | 11 | Yes |
| 3 | Seeley | 550 | Yes | 10 | Yes |
| 4 | Bateman, M. | 500 | Yes | 11 | Yes |
| 5 | Nakash | 450 | Yes | 10 | Yes |
| 6 | Maywood | 400 | Yes | 9 | Yes |
| 7 | McCallum, D. | 350 | Yes | 9 | Yes |
| 8 | Drummond | 300 | Yes | 9 | Yes |
| 9 | Smith | 250 | Yes | 10 | No |
| 10 | Bindman | 200 | Yes | 5 | Yes |
| 11 | Trinfield | 150 | Yes | 8 | Yes |
| 12 | Donaghy | 100 | Yes | 8 | Yes |
| 13 | Talmage | 50 | Yes | 7 | Yes |
| 14 | McCallum, V. | — | Yes | 4 | Yes |

(Mr. Bateman, in charge of party, stationed himself here and timed period of totality carefully with his watch as 4 4/5 seconds.)

| | | | | | |
|---|---|---|---|---|---|
| 15 | Bateman, J. | 50 S-W | Yes | 3 | Yes |
| 16 | Bowen | 100 | Yes | 3 | Yes |
| 17 | Cooper | 150 | Yes | 15 | Yes |
| 18 | McNaughton | 200 | Yes | 20 | Yes |
| 19 | Fearneley | 250 | Yes | 20 | Yes |
| 20 | Bailey | 300 | Yes | 28 | Yes |
| | Mr. Darker | | Yes | 28 | Yes |
| 21 | Luxford | 350 | Yes | 30 | Yes |
| 22 | Pennoyer | 400 | Yes | 29 | Yes |
| 23 | Taylor | 450 | Yes | 28 | Yes |

| *Station* | *Name* | *Yards from Estimated Line* | | *Question* 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| 24 | (Position unoccupied: unsuitable for observation). | | | | | |
| 25 | Drennan | 550 | | Yes | 24 | Yes |
| 26 | Molson | 600 | | Yes | 23 | Yes |
| 27 | Standish | 650 | | Yes | 23 | Yes |
| 28 | Yatt | 700 | | Yes | 23 | Yes |
| 29 | Pope | 750 | | Yes | 23 | Yes |
| 30 | Goff | 800 | | Yes | 22 | Yes |

NOTE—Station 14 (central line) was at Switch 3, 1214 feet (taped) along track northeast from railway crossing.

SUMMARY OF REPORTS—PARTY 8—NEAR GALSON

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Spackman | 850 | N-E | Yes | 20″ | Yes |
| 2 | Wilson | 800 | | Yes | 20 | Yes |
| 3 | Bennett | 750 | | No | 20 | Yes |
| 4 | Edwards | 700 | | Yes | 17 | Yes |
| 5 | Herring | 650 | | No | 17 | Yes |
| 6 | Leech | 600 | | No | 17 | Yes |
| 7 | Metcalfe | 550 | | No | 17 | Yes |
| 8 | MacAllister | 500 | | Yes | 10 | Yes |
| 9 | Badams | 450 | | Yes | 6 | Yes |
| 10 | Campbell | 400 | | Yes | 5 | Yes |
| 11 | Johnston | 350 | | Yes | 5 | Yes |
| 12 | Shea | 300 | | Yes | 5 | Yes |
| 13 | Bell | 250 | | Yes | 5 | Yes |
| 14 | McLean | 200 | | No | 3 | Yes |
| 15 | Lothrop | 150 | | Yes | 5 | Yes |
| 16 | Fournier | 100 | | Yes | 2 | Yes |
| 17 | Kinnett | 50 | | Yes | 2 | Yes |
| 18 | Mayotte | — | | No | | Yes |
| 19 | Bishop | 50 | S-W | Yes | 2 | Yes |
| 20 | Quinn | 100 | | Yes | 4 | Yes |
| 21 | Megor | 150 | | Yes | 15 | Yes |
| 22 | Whittingham | 200 | | Yes | 15 | Yes |
| 23 | Echenberg | 250 | | Yes | | Yes |
| 24 | Jackson | 300 | | Yes | | Yes |
| 25 | Murphy | 350 | | Yes | | Yes |
| 26 | Stewart | 400 | | Yes | 9 | Yes |
| 27 | Barrett | 450 | | Yes | 9 | Yes |
| 28 | Glass | 500 | | Yes | 9 | Yes |
| 29 | Palmer | 550 | | Yes | 9 | Yes |
| 30 | Jones | 600 | | Yes | 8 | Yes |
| 31 | Christison | 650 | | Yes | 7 | Yes |
| 32 | Sarrasin | 700 | | Yes | | Yes |

| *Station* | *Name* | *Yards from Estimated Line* | *Question* 1 | 2 | 3 |
|---|---|---|---|---|---|
| 33 | MacAllister | 750 | Yes | 9 | Yes |
| 34 | Trussler | 800 | Yes | 8 | Yes |
| 35 | Muzzey | 850 | Yes | 7 | Yes |

NOTE—Station 18 (Central Station) was established 175 yards south-west from road corner in Galson.

Observers at Station 34 and 35 were Scoutmasters.

TEMPERATURE READINGS TAKEN BY

Scout G. A. Bergeron, of Quebec, at Station 21, Party 6.

| | | | |
|---|---|---|---|
| 3.30 (D.S.T.) | 88° | 4.20 (D.S.T.) | 75 |
| 3.40 (D.S.T.) | 90 | *4.24 (D.S.T.) | 72 |
| 3.50 (D.S.T.) | 90 | 4.26 (D.S.T.) | 73 |
| 4.00 (D.S.T.) | 84 | 4.40 (D.S.T.) | 74 |
| 4.10 (D.S.T.) | 78 | 4.50 (D.S.T.) | 76 |
| 4.15 (D.S.T.) | 76¾ | | |

*Totality.

## NOTE ON REPORTS OF OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE 1932 AUGUST 31

By A. VIBERT DOUGLAS

In the "Report of the Expedition from the Royal Observatory, Greenwich, to Observe the Total Eclipse of the Sun on 1932, August 31", by C. R. Davidson and J. Jackson ("Monthly Notices, R.A.S." 1932, November) it is recorded that the observed time of 2nd contact was 3 or 4 seconds later than the computed time for Parent, Que., and that the duration of totality was 99 sec. as compared with the 102 sec. computed. The suggestion is made that this discrepancy in the duration of totality is due possibly to two causes, first, a very slight (less than one second) error due to the metronome, and, secondly, a shortening of the period of duration on account of the lateness of 2nd contact, which is ascribed to a flatness on the Moon's limb at that particular point.

In the report of Father Emil Cambron, S.J., of the observations made by members of the expedition from the Collège Sainte-Marie at Ile Saint-Ignace near Sorel, it is said that while second contact appeared to be one second fast, third contact was eight seconds fast; in other words, duration of totality was only 93 seconds instead of the predicted 100 seconds at that station.

In the "Report on Observations of Total Eclipse by Boy Scouts, August 31, 1932", by E. Russell Paterson, the very important conclusion is reached that the eastern edge of the shadow probably lay from 550 yards to 900 yards north-east of the computed line. It is very greatly to be regretted that the unfavourable weather so general across the Province of Quebec on that date frustrated much

of the work so admirably planned by Mr. Paterson, for complete records from all the parties of Scouts on the western as well as on the eastern edge of the shadow belt would have been of the utmost importance and value. They are, however, to be congratulated on what was achieved, and it seems to be worthy of notice that their result has a very definite bearing on the problem involved in the discrepancies between computed and observed duration of totality mentioned in the previous paragraphs.

Both Parent and Ile Saint-Ignace are situated on the west side of the computed central line, the former about 5 miles S.W., and the latter somewhat more. If the entire shadow path were several hundred yards further N.E. than calculated, as the observations of the Boy Scouts might indicate, then of necessity the duration of totality at all places west of the computed central line would be lessened and the time of second contact would be slightly delayed relative to the computed time. Furthermore, this lessening of the duration of totality would be more marked for the place further from the central line. This leaves unexplained the one second discrepancy in observed second contact at Ile Saint-Ignace, but it ties in well with the other facts above mentioned. It therefore seems likely that this was a contributory cause, even though not the entire cause, of the shorter periods of totality recorded in the reports of both these expeditions.

McGill University,
1933 March 23.

## REVIEW OF PUBLICATIONS

*Enseignements de la Cosmogonie moderne* par Emile Belot. 132 pages, 4¾×7¼ in., 14 fig. and 8 pl. Paris, Librairie Bloud & Gay, 1933.

M. Belot is well known as the author of several books on cosmogony, the earliest being his "Essai de Cosmogonie tourbillonaise" which appeared in 1911. The present small volume is number 52 in Bibliothèque catholique des Sciences religeuses.

The headings of the chapters are: 1. Views of the problem of cosmogony. 2. Voyage of study in our universe. 3. Unity of the plan of the genesis of the universe; the principle of dualistic cosmogony. 4. Birth of the planetary system. 5. Evolution of cosmic things, of spiral nebulae and globular clusters. 6. The cosmic heavens, treated in three parts (a) Creative thought revealed by the worlds created; (b) Creative thought revealed in Genesis; (c) The death of the stars and the earth.

The book explains concisely the author's theory of the evolution of the various heavenly bodies, and concludes with the relation of this evolution to religion. The last paragraph is: "The picture which St. Luke gives us of the end of the world strongly resembles that which modern science predicts. Thus having comprehended how cosmic things—the sun and the planets—grow old as do all the living things we understand the terrible realities envisaged in these divine words, 'Heaven and earth shall pass away but my words shall not pass away.'"

C. A. C.

*Mécanique quantique et Causalité* par Audré George. 18 pages, 6½×10 in. Paris, Herman, 1932. Price 6 frs.

This pamphlet is one of a series on theoretical physics published under the direction of L. de Broglie. It discusses the problem of causality in quantum mechanics as propounded by Fermi. Some remarks by L. de Broglie are added.

# NOTES AND QUERIES

**Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.**

CORRECTION TO PLATE II IN THE APRIL JOURNAL.

By an error part B of Plate II accompanying Dr. P. M. Millman's paper in the last issue of this JOURNAL was inserted with the violet end of the spectrum to the right, instead of to the left. The title of the plate should be "Spectra of Meteors."

Dr. Millman reports that on the last meteor plates taken in Arizona there is an exceptionally good spectrum of a fireball, probably the best ever obtained. The plate was exposed on February 26, 1933. It is estimated to have been of stellar magnitude —9.

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AN OVER-ABUNDANCE OF HYPOTHESES.

In an address given at a dinner in honour of Professor Einstein in New York on March 15, Dr. Harlow Shapley made the following remarks:

I suspect that we are too near the front in this battle of nature's secrets against test-tubes, spectroscopes and mathematical analysis to realize how much we pursue current fads, how enthusiastically we over-interpret fragmentary observations of fragments. But even at this close range we can see the oncoming mortality of practically all current theories, both of the microcosmos and of the macrocosmos. There is an over-population of hypotheses; they crowd and cancel one another. New observations add to the slaughter. Within the past year, almost accidentally, we stumble upon fundamentals like the neutron and the positron, entities that had not been explicitly included in the atomic models and pictures of the preceding years. But brave hypotheses are necessary to guide, transiently; the observations stand for a while; the good measures, in fact, are essentially permanent; and the enthusiasm back of it all, the will to know and the willingness to fumble as we learn to know—they are eternal.

The present writer would call attention to the contrast between the use of hypotheses by Newton and by recent physicists as presented in Professor de Sitter's recent book entitled "Kosmos."

ASTROPHYSICAL INSTRUMENTS FOR SALE.

Some time ago Mr. A. F. Miller, one of the original members of the Royal Astronomical Society of Canada, owing to failing eyesight, disposed of his telescope. He now wishes to sell his astrophysical instruments. Attention is directed to a notice at the bottom of page 2 of the cover.

C.A.C.

## NEWS AND COMMENTS

### NOTES FROM THE DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.

Notes from the Dominion Astrophysical Observatory, Victoria, B.C.

In continuation of the observing statistics from the January number of this Journal, we have the following from the records at the observatory:

| | 1932-33 | | 14-year average | |
|---|---|---|---|---|
| MONTH | NIGHTS | HOURS | NIGHTS | HOURS |
| December | 15 | 143 | 9 | 63 |
| January | 9 | 34 | 10 | 68 |
| February | 11 | 65 | 14 | 92 |
| March | 14 | 73 | 16 | 100 |
| April | 16 | 113 | 17 | 92 |

The first half of December was exceptionally good when there were seven nights averaging thirteen hours each. January was particularly poor, the suggested reason by one of the astronomers being that we had resilvered the mirrors expecting a good month. February and March were each below whilst April was somewhat above the average.

The number of visitors to the observatory fell off greatly during 1932. The approximate total was 13,259 as compared with 24,840 in 1931 and 39,027 for the peak year, 1929. Quite an index of the depression! The past month, however, has seen quite an increase above the normal, there being approximately 1,000, although several large groups, like the sailors from the Japanese warships which visited our city, helped to swell the total.

In February we had a short visit from Mr. and Mrs. Cox, who were going back to England to retire. Mr. Cox has been connected for about 27 years with the cable station at Bamfield, halfway up the west coast of the Island.

Dr. N. J. McLean, President of the Winnipeg Centre of the Royal Astronomical Society last year and one keenly interested in astronomy, spent a short time in Victoria the past winter and sat in with us at one of our Monday seminars.

Dr. Charles Hujer, associated with several observatories in the United States and Mexico at different times and who was in attendance at the I.A.U. meeting at Harvard in September last, was a visitor recently. He had come from the observatories in Texas and California, and was returning to Czecho-Slovakia.

The observatory library has been enriched by the gift from Professor Paul Helbronner of France of eight large volumes, descriptive of his geodetic work in the Alps, accompanied by a large case of panoramic photographs. Some of the latter are coloured and give a wonderful impression of Alpine scenery. Professor Helbronner was one of the party of visiting scientists from Europe who made a tour of the Western observatories just preceding the eclipse of August last. That trip, by the way, was written up in a most interesting and "catchy" style by Mr. W. H. White, one of the party, and appears in booklet form.

The Director, Dr. J. S. Plaskett, was this year's special lecturer from the observatory to Vancouver. To the members of the Vancouver Institute he spoke on "The Expanding Universe". To the Astronomical Society he gave a talk on "Diffuse Matter in Space", whilst to the Physics Club of the University he outlined the modern conceptions of "The Structure of the Galaxy".

The Physics Club of the University of B.C. journeyed to Victoria one Saturday afternoon recently, visiting the Gonzales Meteorological Observatory in the early afternoon and our own observatory at night. The Vancouver Centre of the Astronomical Society plan to do the same thing this Saturday week-end, May 6th. It is hoped they will bring clear weather with them or at least leave the clouds of Vancouver behind them. The local Centre is making plans for their visit.

Our congratulations are cordially extended to our colleague,

Dr. C. S. Beals, on his election as Fellow of the Royal Society of Canada.

Dr. J. A. Pearce plans to attend the May meeting of the Royal Society of Canada in Kingston where he will present six papers by members of the staff. This will be his first appearance at the Society since his election a couple of years ago. He will be accompanied by Mrs. Pearce and later will visit at his old home in Brantford, Ontario, and returning by way of Chicago, will take in the meetings of the American Astronomical Society there in mid-June.

From June 1 to 15 the Fifth Pacific Science Congress will be in session in Victoria and Vancouver. The first four days will be spent in Victoria, the remainder in Vancouver. Following the meetings of Congress a tour will be made of the province, ending at Calgary, Alberta, on the 19th June. Invitations have been extended to about 30 countries bordering on the Pacific and it is expected that several hundred of the leaders in various branches of science will be present.

W.E.H.

# MEETINGS OF THE SOCIETY

## AT VANCOUVER

*February 17, 1933.*—The fourteenth regular meeting of the Vancouver Centre was held at the University of British Columbia. The President, Mr. Teasdale, was in the chair.

The speaker of the evening was Dr. J. S. Plaskett, Director of the Dominion Astrophysical Observatory at Victoria, who was introduced by Mr. Teasdale.

Dr. Plaskett commenced by congratulating the members of the Vancouver Centre on the work which has been done in establishing a successful Centre here.

Turning to his subject, "Diffuse Matter in Space," Dr. Plaskett pointed out that study along these lines is a recent development in cosmogony. Sir William Herschel with his twenty-foot telescope observed luminous objects in the sky which he called nebulae. The presence of diffuse gaseous matter in these nebulae was not recognized until the work of Sir William Huggins with the spectroscope showed that the spectra were different from those of the stars, in that they contained bright emission lines of hydrogen and helium, as well as some lines which have no terrestial analogue and were attributed to an hypothetical element, nebulium. This substance remained mysterious until the work of Bowen at the California Institute of Technology led to the conclusion that these lines were due to oxygen and nitrogen at extremely low temperature and pressure.

Hubble, some twelve years ago, postulated that the luminosity of these nebulae was induced by the excitation of some hot star. The nebula around the Pleiades, for example, shows no bright lines but a continuous spectrum which is a replica of that of the central stars.

In some other nebulae we find a combination of bright and dark lines, the dark lines being due to absorption. The question of the presence of other matter between the stars was discussed.

In 1904 Hartman studied the spectrum of Delta Orionis, a spectroscopic binary, and noted, in addition to the broad diffuse lines of *H* and *He, Ca, H* and *K* lines which were quite sharp and showed no Doppler shift. These stationary calcium lines are apparently not due to the star itself but to an intervening cloud of calcium gas. In the same year a number of B type spectroscopic binaries with stationary calcium lines were discovered by Frost at Yerkes. Slipher of Lowell Observatory, who obtained the Gold Medal of the Royal Astronomical Society this year, investigated these B type stars and came to the conclusion that diffuse calcium gas must be widely distributed in space. He also noted stationary sodium D lines. By correcting for the

component of solar system motion Slipher was able to demonstrate the stationary character of these lines.

In 1920 Dr. R. K. Young, now of Toronto, collected data on these lines and showed that they only occurred with stars of higher temperatures than 20,000°, and also were associated only with binaries. The material producing the lines was a gas surrounding the binary system. Dr. Plaskett, however, was able to find a star for which these conclusions did not hold, since for an eclipsing binary he found the *Ca* lines with low speed of approach, the star apparently escaping from the surrounding cloud.

Dr. Plaskett also studied the motions of O type stars, the stars of highest temperature and greatest mass. Stationary *Ca* lines were found present in the spectra of all O type stars, whether binary or not, leading to the conclusion that *Ca* gas is widely distributed and is nearly stationary with respect to the stellar system. It is possible that the diffuse matter may contain other elements than *Ca* and *Na* but only those two give lines in the visible part of the spectrum. This gas matter is ionized and excited by radiation from neighbouring stars.

In 1926 Eddington considered on theoretical grounds the properties of this diffuse matter and obtained a density of $10^{-24}$ grams per cubic centimeter. Later at Harvard this density was deduced as $10^{-26}$ gm./cc. These figures correspond to about one atom per cubic centimeter with a mean free path equal to the distance of the earth from the sun. The temperature of the gas, deduced from molecular speed is 20,000°C, this however, being an effective temperature only. Under these conditions calcium should be doubly ionized but there are no prominent lines in the observable spectrum. One part in 3,000 should be singly ionized and visible absorption should be obtained after the light from the star has traversed a thickness of 500 light years (the work at Victoria shows an 800 light-year minimum).

Harper and Plaskett have carried on a series of observations on O and B type stars, including over 1,000 high temperature stars. Of these 314 showed the interstellar *Ca* lines.

Dr. Plaskett then spoke of his own work in connection with the rotation of the galaxy. The velocity of rotation is 300 km. per second at the neighbourhood of the sun, and the time for one complete revolution is 200 million years. Since the mass of the system is fairly well concentrated around the centre of the galaxy the rotation is similar to planetary motion and the stars nearer the centre move faster than those further away. Evidence of this rotation is obtained from a study of the motions of high temperature stars. The motions of these may be ascertained from the apparent motion of the diffuse matter and the results agree with the motions obtained by other means.

Distances of stars may be obtained from measurements on galactic rotation and may also be measured by means of the intensity of the calcium lines, since there exists a straight-line relationship between the intensity of the lines and the distance. The actual distance should be twice that of the

centre of gravity of the interstellar diffuse matter. The difficulty of applying this method lies in the absence of these lines with the low temperature stars.

Dr. J. A. Pearce has discovered broad *Ca* lines due to the star itself in the case of the most luminous and massive stars.

Summarizing, the speaker called attention to the discoidal shape of our stellar system, this thin disc containing some 100,000 million stars. The average mass of these is a little less than that of our sun, and the average distance between stars five to ten light-years. All the intervening space is filled with gaseous star-stuff. Eddington has shown that both stars and diffuse matter obey the same law in that they rotate about the centre of gravity of the galaxy.

The lecture was illustrated with slides and at its close Dr. Plaskett answered a number of questions.

WILLIAM URE, *Recorder.*

*March 14, 1933.*—The fifteenth regular meeting was held at the University of British Columbia. The president, Mr. Teasdale, was in the chair.

The April meeting of the Centre will be devoted to a consideration of telescope-making and is intended to be an informal gathering at which the members will have an opportunity to become better acquainted with one another. As it is desired to form a telescope-makers' group those interested were requested to get in touch with the secretary.

Mr. Teasdale introduced the speaker for the evening, Dean D. Buchanan, our Honorary President, who spoke on "Stellar Motions."

It was the great astronomer Halley who in the early part of the eighteenth century, discovered the motion of the stars. The discovery came as a result of the comparison of the positions of Arcturus and Sirius, measured by Halley, with their positions given by the star charts of Ptolemy in 120 A.D. This method of measuring star motions is still used; corrections being applied for the motion of the earth's axis aberration and parallax. After computation and elimination of these factors the residual motion is the proper motion of a star. The greatest proper motion is that of Barnard's star, being 1° in 350 years. Another method makes use of the "blink" microscope involving photographs taken of the sky at intervals of ten to twenty years.

The method of determining radial velocities from the Doppler shift of spectral lines was then explained and illustrated with slides. The radial velocities of some 5,000 stars have been measured and the values are found to be comparable to the motions of the planets. The speaker mentioned the enormous radial velocities which have been obtained by Hubble at Mt. Wilson for some of the nebulae, the two in Gemini having values of 2,400 km. per second. Since most of these velocities are velocities of recession the universe would seem to be expanding at a tremendous rate.

The cross velocity of a star may be obtained from a formula involving the proper motion and the parallax. Alpha Centauri will be nearest the sun in 30,050 A.D. and will only have approached it by one light year.

The question of moving clusters was next discussed. Here it is found that a number of stars seem to be moving towards the same convergent point, a result which can be interpreted to mean parallel motion. This provides another means of measuring star distances.

The motion of the sun through space is made evident by the drift in stellar proper motions and the direction and magnitude of this motion may be calculated. If the proper motion of a star is corrected for the sun's motion the residue is the peculiar motion of the star.

The phenomenon of star-streaming was then described. Discovered by Kapteyn, the two directions of streaming have been worked out by Eddington. This behaviour seems to be characteristic of A type stars but absent in B type.

In connection with double stars it was pointed out that Sir William Herschel was a pioneer in this field. The extensive work of S. W. Burnham led to the publication of his star catalogue in 1906. During the course of his work Burnham discovered as many as twenty-six double stars in one night. The characteristics of the visual binaries were described and it was shown how the masses of the components could be determined. Sirius and its companion form an interesting couple in which the ratio of the masses is 5 to 2 while that of the intensity is 10,000 to 1.

Diagrams of star velocities in the case of spectroscopic binaries were shown and the methods of measuring the masses of the components described. At least one quarter of the stars in the heavens are binary and of these at least 10 per cent. are multiple.

The speaker concluded by outlining the fission theory of Jeans which accounts for the formation of binaries.

In answering a question Dean Buchanan informed the members that March 14 was Einstein's fifty-fourth birthday.

WILLIAM URE, *Recorder.*

## AT WINNIPEG

*January, 11, 1933.*—The first regular monthly meeting of the year was held in Theatre A., University Building.

The retiring president, Dr. N. J. MacLean, introduced the new president, Mr. A. W. Megget, paying tribute to his deep interest and advancement made in the study of the stars since joining the Society in 1921.

Mr. Megget spoke briefly of his two main ambitions, one, to be president of the Royal Astronomical Society, which was now realized, and the other, to complete half a century as an active cricketer in Manitoba, which also will be realized if he is spared and able to play during the coming summer of 1933.

We hope that Mr. Megget will reach well beyond the half century of cricket-playing and also have time to learn much more of astronomy before going on his star-paved way amongst the celestial cities of the heavens.

A letter was read from Dr. J. S. Plaskett, acknowledging and accepting with pleasure his appointment as Honorary President of the local centre of the Society. The following were elected members, the addresses of all being in Winnipeg:

Miss Elsie A. Corrigan, 14 Locarno Apts., 1 Roslyn Rd.
Professor F. W. Brodrick, 31 Furby St.
Mr. W. R. Junkin, 12 Riverside Apts., 42 Langside St.
Mr. Spencer Dutton, 124 Harrow St.
Miss Olive A. Armstrong, 21 Queen's Apts., 520 Maryland St.
Mr. L. A. G. Lardner, 276 Inkster Blvd.
Miss Marguerite Murray, 9 Karlston Apts., 537 Victor St.

Dr. Warren reported his selection of about forty astronomical books and having them placed in the library available for use of the members.

The first speaker of the evening was Dr. L. A. H. Warren whose subject was "The Redward Shift." Dr. Warren spoke of the analogy between light and sound, also between light waves and radio waves. In red light, we find that approximately 400 millions of millions of waves strike the eye, whose retina pulsates for every wave, between two ticks of a clock. In violet light the vibrations are about 700 million million per second. Illustrations of refraction of rays through prisms were shown. By knowing the length of light waves, we can tell the substances in heavenly bodies. By watching the lines of the spectrum and observing whether they shift towards the violet or the red, it can be known if the stars are going from us or approaching. If approaching, they shift towards the violet and if going away, towards the red, so "The Redward Shift."

The second lecturer, Mr. A. R. McCauley of the Dominion Meteorological Office, spoke on "Weather Facts and Popular Fallacies." Mr. McCauley proved from careful observations that little if any reliance can be placed on the many old-time weather maxims and axioms, as the March lion and lamb, instinct of animals, prognostications of Indians, etc. The clear sky produces the frost and not the full moon, contrary to many opinions. No weather maxim is reliable unless carefully investigated and compared with synoptic charts, over a long period of time.

The barometer is the instrument used to measure the pressure or weight of a column of air from the place of observation to the top of the atmosphere. Pressure is defined in terms of the height of a column of mercury it will support, the weight of a column of air of a unit cross section over the place of observation. It is well-known that weather obeys physical laws and so meteorological processes are explained on physical principles.

The processes which make the weather what it is might be likened to a great steam or atmospheric engine which pumps the atmosphere from one

place, causing low pressure and stormy weather, and piles it up elsewhere giving high pressure and probably fine weather. So winds are created which carry moisture from the tropics to many other regions. To produce a crop of 400 million bushels of wheat, 12,000 million tons of water would be necessary.

Meteorology began to take its place as a science in the 17th century when weather forecasting was attempted by means of the weather glass, which even then used the same designations as have been in use ever since.

By telegraph, telephone and radio, weather news is carried from the Atlantic to Pacific and from Mexico to the Arctic and charted on maps at Toronto, Winnipeg and Victoria, within 40 minutes of the times of observations. Lines are drawn through places of equal pressure and these form closed curves which have two great outstanding systems: one showing low pressure at the centre and increasing outwards, the other showing high pressure at the centre and decreasing outward. In the first the air has been pumped out, drawn off from the top, the air is cooled moisture condensed and there is rain. In the second, the high or anti-cyclone area, the air has been piled up, settles down and flows out from the base. These are the two pressure systems shown on the *synoptic* maps.

It is believed that our weather in temperate latitudes is produced by two great currents the equatorial and the polar. The equatorial is generally warm and moisture-laden; the polar cold and dry. Though so different, they can exist side by side, for long distances, without mixing. Our stormy and bad weather occurs along the lines of separation, or "discontinuity," and so we have the "wars of the elements." The warm equatorial air (the south army) ascends and drives back the cold polar air, giving first, rain, then heavy clouds (alto-stratus and alto-cumulus) then further, the thin wispy clouds (cirrus) the vanguard of the approaching storm. In the region of the nimbus cloud or along the so-called "warm-fronts," the steady rain or drizzle occurs, or fog, but seldom thunder-storms. The polar currents (the north army) sweep around to the flank (reinforced by fresh cold air from the north) and undercuts the equatorial current, forcing it up and causing hail, thunderstorms, tornado, and line-squal, so-called because of preserving its identity, hundreds of miles. Passing this region, the clouds clear rapidly, and we have the dry clear air from the poles. The great cold winter airwaves gradually warm up in passing over the continent, take up moisture, and lose much of their polar characteristics.

Sometimes the cold air may cut right through the warm, giving warm equatorial air, but cut off from the base of supply, and the storm dies. Again, the warm air may attack the cold and there is another storm—the battle fought all over again. Sometimes the equatorial current may penetrate far north, so giving warm or hot weather and little rain, or the polar may go far south and there are cold winters.

*January 25, 1933.*—The first members' meeting of the year was held in Theatre "A," University Building, at 8.15 p.m.

The president, Mr. A. W. Megget, gave a brief summary of the study of astronomy from the time of Ptolemy whose geo-centric theory prevailed for thirteen centuries until Copernicus introduced his helio-centric innovation which was eventually established in spite of much conflict. All this time men had observed the heavens with only their naked eyes but when the "optic tube" was discovered, a new universe was unveiled, which has been enlarging ever since.

Mr. D. R. P. Coats, leader for the evening, speaking on "Amateur Telescope Making" demonstrated the advance made since the time of the "optic tube." With his own telescope, he illustrated its construction. He showed how the mirror is shaped, and polished, first with carborundum then finer and finer powder until finished off with jewellers' rouge. Much patience is required to get the exact parabolic shape and absolute cleanliness is necessary. He described the process of silvering the mirror which demands careful work. Then to preserve the silver surface from tarnishing, silversmiths' lacquer is used. Much ingenuity was shown in the development of the mounting, proving that one with an inventive mind, can "find a way or make it."

J. C. Howey, *Assistant Secretary.*

## AT VICTORIA

*January 27, 1933.*—The first regular meeting of the spring session was held with President P. H. Hughes in the chair and about forty members and visitors present.

Mr. G. Browne-Cave gave a clear explanation of Roemer's method of determining the speed of light by eclipses of Jupiter's satellites.

Lt.-Comdr. F. L. Houghton, R.C.N., Esquimalt, B.C.

W. J. Stafford, Esq., Victoria, B.C.

were elected to membership.

The president then introduced Lt.-Comdr. R. H. Tingley, R.C.N., who spoke on "The Uses of Astronomy in Navigation." The modern method of determining a ship's position, due to St. Hilaire, a French naval officer, by means of position lines from observations of celestial objects was explained, the method having the advantage that errors in dead reckoning were eliminated.

Responding to questions Comdr. Tingley described in some detail the gyro-compass. The British design of Brown had the best method of supporting the moving parts; being carried on a jet of oil it was practically frictionless, whereas the Sperry suspension by 17 wires and the German floatation in mercury were not as successful; the wires rusted and the mercury got dirty.

*February 17, 1933.*—The second spring meeting; some 55 present. A 5-minute talk on Orion was given by W. R. Hobday, who drew attention

to the great range in size and luminosity of the principal stars of the constellation.

Miss Mollie Little of Victoria was elected a junior member and J. R. Genge, of Cambridge, England, was elected to membership.

Dr. Helen Sawyer Hogg, then lectured on the Magellanic Clouds. The large cloud is some 112,000 light-years, the small cloud some 104,000 light-years distant, the clouds being about 39,000 light years centre to centre distance. In her most instructive and interesting address during which some of the open and globular clusters in the clouds were described, Dr. Hogg said that from a study of the Cepheid variables in the small cloud Miss Leavitt of Harvard Observatory had been able to show the definite relation between period and luminosity of Cepheids, which has become of immense value in the estimation of distances beyond the reach of other methods. Several interesting lantern slides of light curves of these stars determined by Dr. Hogg were shown.

*March 10, 1933.*—A capacity meeting listened with great interest to Dr. J. S. Plaskett's address on "The Expansion of the Universe."

Following a 5-minute talk by W. F. Holdridge on Michelson's determination of the speed of light, Mr. James Duff, M.A., honorary president, introduced Dr. Plaskett. This address in full will appear in a later issue of the JOURNAL.

H. BOYD BRYDON, *Secretary-Treasurer.*

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